Winding or rewinding machine for producing rolls of web material around a winding spindle and relative winding method

Description

Technical field

The present invention relates to a machine for producing rolls of web material wound around winding spindles.

Machines of this type are used for example to produce rolls or reels of paper, tissue-paper, non-woven fabric and other web or sheet material.

Winding machine is usually intended as a machine which receives the web material from a production machine upstream and winds it to form a roll or reel of large diameter. Rewinding machine is usually intended as a machine which receives web material from a roll or reel with a large diameter and rewinds it into rolls of a smaller diameter. In both cases the web material may be cut longitudinally in continuous strips, with which several rolls are formed in parallel simultaneously on the same spindle. The term roll or reel is intended, in the context of this document, both as a whole roll or reel and as a series of coaxial rolls placed side by side on the same winding spindle.

Unless otherwise specified, spindle must be generically intended as a spindle made of metal or another suitable material, or an assembly composed of a rod or spindle, positioned and clamped on which are one or more cores in cardboard or another material, typically non-electrically conductive material.

More specifically, the invention relates to a peripheral winding or rewinding machine, that is in which the roll being formed is maintained in rotation by one or more moving elements in contact with the external surface of the roll. Typically, the element or elements which transmit, through friction, the rotating movement to the roll being formed are composed of one or more winding rollers or cylinders.

The invention also relates to a new method for producing, in particular with a peripheral winding procedure, rolls or reels of web material.

State of the art

In production of this type of roll, one of the critical aspects is constituted by the initial winding phase, that is the operation through which the initial free end of the web material, produced by the interruption of said material, starts to be wound

forming the first turn around a new winding spindle.

Frequently, the initial free end of the web material is made to adhere to the winding spindle (or more precisely to tubular cores made of cardboard or another suitable material, such as plastic or the like, positioned and clamped on an inner metal spindle) by applying an adhesive. This makes it necessary to provide a gluing unit which applies the adhesive to the cores or to the spindle prior to insertion in the winding zone. The presence of adhesive in winding or rewinding machines represents a considerable disadvantage as, in addition to the costs deriving from the consumption of adhesive, it inevitably soils the various mechanical parts of the machine and its products. The presence of adhesive is unacceptable in some types of reels, such as those destined for producing hygiene articles such as medical products, diapers and sanitary towels.

In other prior art machines the initial free end is wound, to form the first turn around the spindle, with the aid of jets or air. This method also has some disadvantages. In the first place, the use of jets of air requires the presence of nozzles and a compressed air line, with the consequent plant layout cost and cost deriving from power consumption to supply the compressed air. The use of compressed air increases the noise of machines and, moreover, does not guarantee reliable and regular start of winding. In particular, when several strips of web material are wound in parallel on aligned tubular cores, the use of compressed air may cause the head of the strips to veer to the side, thus causing them to overlap with the consequent problems during production.

In some applications, the initial free end of the web material is made to adhere to the winding spindle with an electrostatic system. This technique charges the web material electrostatically immediately prior to cutting, producing a difference in electric potential between the web material and the winding spindle. This difference in potential attracts the web material towards the spindle causing the former to adhere to the latter and thus commencing winding of a new roll.

This technique is frequently used in winding or rewinding machines of the central type, that is where the winding movement is imparted directly to the spindle, instead of through a peripheral winding system. Examples of the use of electrostatic charges to make the web material adhere to the winding spindle in a

central winding system are described in the patent USA 4.852.820, the patent USA 5.823.461, the patent USA 5.845.867 and the patent USA 6.264.130.

In peripheral type rewinding or winding machines the application of this technology is more difficult, for the reasons set forth below. Peripheral rewinding machines are currently preferred for several reasons, linked both to the improved operation of these machines and to their higher production level. Examples of rewinding machines to which the present invention may be applied are described in the patent USA 4.422.588, the publication WO-A- 99/02439 and the publication WO-A- 00/61480.

Electrostatic bars are used to electrostatically charge the web material, that is electrically conductive bars connected to an electric voltage source. These are commonly employed to ensure correct start of winding of the new roll on winding machines that do not have rollers in contrast with the winding spindle (as is typically the case in central winding or rewinding machines), or that have a single roller contrasting the reel or winding spindle.

When the winding or rewinding machine is constructed so as to present one or more rollers in contact with the spindle in the initial phase to form a new roll, there is the risk of the web material not being wound correctly around the spindle. If, in fact, the initial end of the web material during its first turn (that is while forming the first turn of material around the spindle) is in contact both with the winding spindle and the contrast roller in the same point, it may detach from the spindle and adhere more firmly to the contrast roller.

If the geometry of the machine allows the free end of the web material, electrostatically charged, to adhere alternatively to the spindle or to the contrast roller, it will adhere to the element with a greater electric capacitance.

Usually, the contrast or winding rollers, in contact with the winding spindle and with the roll being formed, have larger dimensions than the spindle and, unlike the spindle, are not coated with non-conductive material, while the winding cores, made of cardboard or another non-electrically conductive material, are normally positioned on the spindle. This means that the contrast or winding rollers have a greater capacitance than the spindle. As a result the web material tends to adhere, with its initial free end, to the contrast or winding roller instead of to the

spindle. When this occurs the machine must be stopped and the web material which has wound around the roller must be removed before restarting production. This causes a waste of material and considerably long machine idle times with consequent loss of production.

Objects and summary of the invention

The object of the present invention is to produce a winding or rewinding machine which does not have the aforesaid disadvantages and allows each roll to be initially wound around the winding spindle easily and securely, by using electrostatic systems to make the initial free end of the web material adhere to the winding spindle, or to the winding cores present on the spindle.

These and other objects and advantages which shall become clear to those skilled in the art by reading the text below, are obtained in substance according to the invention by a rewinding or winding machine of the type comprising in combination: at least a roller in contact with the winding spindle in the initial phase of winding the web material around the spindle; a cutting element to cut the web material at the end of winding a roll and form an initial free end for winding a subsequent roll around a new winding spindle. Characteristically, according to the invention at least an electrostatic bar is provided to electrostatically charge the web material, and the roller in contact with the spindle is made at least partially in non-electrically conductive material. As specified above, in this context spindle is intended as a whole as the assembly composed of the actual rod or spindle and by any tubular core positioned and temporarily clamped on the spindle and around which the web material is wound. Therefore, roller in contact with the spindle is generically intended as the roller which comes into contact with the surface of the actual spindle when it has no tubular core positioned on it, or the roller which comes into contact with the external surface of the tubular core positioned on the rightly called spindle, which remains inside the tubular cores.

By producing at least the cylindrical surface of the roller in contact with the winding spindle in non-electrically conductive material, the electrical capacitance of the roller is reduced drastically, so that the initial free end produced by cutting the web material adheres securely to the winding spindle, or to the cores positioned on the spindle, allowing secure and reliable start of winding and

avoiding the risk of the material being wound around the roller instead of around the spindle.

Although it is possible to reduce the electric capacitance of the roller in contact with the winding spindle by a coating of non-conductive material which covers, with an adequate thickness, the cylindrical surface of the roller, it is preferable to produce the whole cylindrical wall of the roller with said material, for example in the form of a cylindrical sleeve, at the ends of which metal roll ends, for example made of steel, are connected, with the supporting shanks or pins also made of steel. The non-conductive material may for example be a synthetic resin reinforced with glass fibers or other non-conductive fibers, in Kevlar or the like, although it is also possible to use different materials, as a function of the characteristics of mechanical resistance and the dimensions that the roller must have.

The roller in contact with the winding spindle, made in non-electrically conductive material, may be a winding roller that remains in contact with the roll being formed around the spindle substantially for the entire winding cycle of the roll. For example, in a rewinding machine comprising two winding rollers defining a winding cradle on which the roll being formed rests, one of the two winding rollers may be made of non-conductive material, or at least coated with this material on its cylindrical surface.

In a rewinding machine of this type, according to a particularly advantageous embodiment of the invention, the electrostatic bar and the cutting element are mounted on an assembly oscillating around the axis of rotation of a first of said winding rollers, with at least the second of said winding rollers being made at least partially of non-electrically conductive material.

According to a different embodiment of the invention, the machine may be a winding machine, or a so-called winder or reeler, provided with a support for the winding spindle, and on which the winding spindle and the roll being formed around said spindle are maintained in rotation by said winding roller, around which the web material is driven.

A machine with this configuration may be provided with a moving assembly carrying the cutting element and the electrostatic bar, said assembly performing a

rotating or oscillating movement around the axis of the winding roller to insert a winding spindle, cut the web material and fasten the web material around said winding spindle. A machine of this type may cut the web material and commence winding without interrupting feed of the web material, that is at a more or less constant and in any case continual feed speed.

In a different embodiment the machine comprises a support for the winding spindle, a winding roller in contact with the roll being formed, to maintain the roll in rotation while it is being formed, a moving assembly carrying the electrostatic bar, the cutting element and the roller in contrast with the spindle, in non-electrically conductive material. This roller may be provided with a movement in relation to the moving assembly which draws it towards and moves it away from the winding spindle.

The object of the invention is also to provide a winding method which makes it possible, in a reliable and secure manner, to start winding the various rolls on the winding spindles using an electrostatic system to make the initial free end adhere to the winding spindle.

Therefore, according to a different aspect, the invention relates to a method for producing rolls of web material wound around a winding spindle, comprising the steps of:

- winding a first roll of web material around a first winding spindle;
- bringing a second winding spindle in contact with the web material;
- cutting the web material, in proximity to said second winding spindle to form an initial free end and a final free end of web material;
- winding the initial free end of the web material around said second spindle and starting to wind a second roll, said web material being retained, in proximity to said initial free end, between said second winding spindle and said roller;

characterized in that said roller is formed in non-electrically conductive material.

In particular, the roller made of non-conductive material may be a winding roller, said rolls being wound with a peripheral winding system.

Further advantageous characteristics and embodiments of the method and of the machine according to the invention are indicated in the attached dependent

claims.

Brief description of the drawings

The invention shall now be better understood according to the description and the attached drawings, which show non-limiting practical embodiments of the invention. In particular, in the drawing:

Fig. 1 shows an overall view of a rewinding machine to which the invention is applied;

Fig. 2 shows an enlarged detail of the nip between the winding rollers in which winding of each roll commences;

Fig. 3 shows an overall view of a winding machine to which a second embodiment of the present invention is applied;

Fig. 4 shows a view analogous to the view in Fig. 3 in a different position of the machine elements;

Fig. 5 shows an enlargement of the zone in Figs. 3 and 4 in which winding commences on the machine;

Fig. 6 shows a schematic side view of a different winding machine to which the invention is applied;

Fig. 7 shows a side view analogous to the view in Fig. 6, in a different machine layout; and

Fig. 8 shows an enlarged detail of the zone in Figs. 6 and 7 in which winding commences on the machine.

Detailed description of the preferred embodiments of the invention

Figs. 1 and 2 show a first application of the underlying concept of the invention to a so-called rewinding machine and more specifically a peripheral rewinding machine of the start-stop type.

The rewinding machine, generically indicated with 1, receives from a reel with a large diameter, indicated with B, a web material N which is rewound on rolls with a smaller diameter, indicated with R. The rewinding machine comprises two winding rollers 3, 5 which define a winding cradle 7, in which the rolls R are formed. After these rolls have been formed they are unloaded onto a carriage indicated with 9, which picks up each roll and transfers it towards an unloading zone. The web material N is fed into the winding cradle passing through a nip

between the two winding rollers 3, 5, under which, in a per se known manner, an assembly of cutting blades 11 are positioned to divide the web material N into individual longitudinal strips, each of which is wound onto a respective core made of cardboard or another suitable material, positioned axially on a metal spindle. In practice, therefore, in this case the roll R may be formed of a plurality of rolls of a shorter axial length aligned with one another along the axis of the winding spindle.

The enlarged view in Fig. 2 shows a metal spindle 13 and a winding core 15 mounted axially on the spindle. In a per se known manner, the metal spindle 13 is expandable to clamp the various cores 15 on it in the desired position. It is also possible for a single winding core to be positioned on a single spindle 13 and in this case the web material N is not divided into longitudinal strips by the blades of the assembly 11.

In the layout in Fig. 1, the rewinding machine 1 has just finished winding a roll R, which has been unloaded onto the carriage 9, while the web material N has not yet been cut to start winding a subsequent roll. To cut the web material N and start winding a new roll around the new spindle which, in a per se known manner, has been placed in the cradle between the winding rollers 3 and 5, a unit or assembly indicated as a whole with 17 is provided, hinged around the axis 3A (Fig. 2) of the winding roller 3.

The assembly 17, as shown in the detail in Fig. 2, comprises a transverse cutting element, indicated with 19, operated by a piston-cylinder actuator 20. Positioned adjacent to the transverse cutting element 19 is an electrostatic bar 21, connected to a high voltage source, not shown. The voltage of the bar 21 may typically reach 60 kV.

Also positioned on the assembly 17 is a guiding roller 23, and a curvilinear section bar 25. As shown in the representation in Fig. 2, by rotating the assembly 17 clockwise from a downward position out of sight under the winding rollers 3, 5 to a position raised above the winding cradle 7, the still integral web material N which extends between the completed roll R and the spindle 13 inserted in the winding cradle 7 to start winding the new roll, partially encircles the assembly 17, as it is driven around the guiding roller 23 and around the section bar 25. A portion of web material is thus held in tension between the edge of the section bar 25 and

the nipping point between the spindle 13 and the winding roller 3. This portion of web material N is charged electrostatically by the electrostatic bar 21 and cut by the transverse cutting element 19. The electrostatic bar can start to electrostatically charge the web material before its feed is interrupted, so that an adequately long portion of material is electrostatically charged.

The final free end which is formed by cutting remains on the finished roll R, while the initial free end must be fastened to the spindle 13, or more precisely to the tubular cores 15 positioned and clamped on this, to start winding the new roll. For this purpose, electrostatic charges have been applied to the web material by the electrostatic bar 21. In order for the initial free end to wind correctly around the spindle 13, instead of around the winding roller 5, the latter is made of non-electrically conductive material, typically in resin reinforced by glass fibers. As, on the other hand, the spindle 13 is metal and is electrically grounded, that is at zero potential, the free end of the web material adheres to the spindle through electrostatic effect and is drawn by the rotatory movement of the spindle to form the first turn. Once the first turn has been formed, the web material is firmly fastened to the spindle.

The winding roller 3 may be made, as is traditionally the case, of electrically conductive metal. This is possible as the specific position in which the initial free end of the web material is produced means there is no risk of its adhering to the roller 3 instead of the winding spindle 13.

Figs. 3, 4 and 5 show a winding machine or reeling drum to form rolls or reels R of web material N, for example fed directly from a production machine. With initial reference to Figs. 3 and 4 the machine, indicated as a whole with 41, comprises a pair of supporting surfaces 43 resting on which time by time with its ends is a winding spindle 45, around which a roll R of web material N is formed. The spindle around which the roll or reel is being formed is retained by two pairs of rollers 47 carried by slides 49 which translate on guides parallel to the supporting surfaces 43 to retain the winding spindle 45 and the roll being formed in contact with a motor-driven winding roller 51 which rotates around a fixed axis of rotation 51A. The web material N to be wound is driven around the winding roller 51, which also transmits, through friction, movement to the roll being formed.

Other winding spindles 45, positioned and clamped on which are tubular cores in cardboard or another non-electrically conductive material, are found standing-by above the winding zone and are inserted one by one in the zone in which winding commences by a mechanism illustrated in Figs. 3 and 4. This mechanism comprises an oscillating unit 55 hinged around an axis 57 and controlled by a piston-cylinder actuator 59. In a per se known manner, the unit 55 picks up, with the aid of a gripping jaw 61, the individual spindles 45 and, through an oscillating movement around the axis 57, brings them adjacent to the winding roller 51 and resting on the surfaces 43.

In this and in the subsequent examples it must be understood that the spindles may also be used without tubular cores positioned on them. In this case, as well, it is advantageous to use a roller in non-conductive material, although the spindle is conductive and therefore designed to attract the electrically charged free end of the web material. In fact, in general these spindles normally have smaller dimensions and masses to the adjacent winding or driving rollers, and therefore have a lower electrical capacitance if these rollers are made of metal.

An assembly 67 oscillates around an axis parallel to the axis 51A of the winding roller 51, controlled by an electric motor 62, with crown gear and pinion transmission 63, 65. The assembly 67 carries: a transverse cutting element 69, an electrostatic bar 71 and a contrast roller 73. The contrast roller 73 is mounted on a pair of sides 75 hinged to the assembly 67 and oscillating in relation to this controlled by a piston-cylinder actuator 77. A second piston-cylinder actuator 79 controls the movement of the transverse cutting element 69. The assembly 67 also supports a pair of guiding rollers 80 and 81.

During winding of a roll or reel R, the spindle 45 on which the roll is being formed is held in contact with the winding roller 51 by the slide 49 and the rollers 47 mounted on this. A new spindle 45, on which the next roll will be formed, is in the meantime positioned on the unit 55. When the roll R is almost completed, it is moved away from the winding roller 51, while the new spindle engaged by the unit 55 is transferred, by a clockwise oscillating movement around the axis 57 of the unit 55, to the zone in which winding commences, in contact with the surface of the winding cylinder 51.

Simultaneously the assembly 67 is made to oscillate counter-clockwise around its axis of oscillation to be inserted between the new spindle 45 lowered by the unit 55 and the roll R just formed. The oscillating movement of the assembly 67 causes a loop of web material N to form, driven around the new spindle 45 and the guiding rollers 80 and 81. The unit 55 and the assembly 67 are moved without requiring to stop feed of the web material, although slowing of the feed speed is not excluded. When the assembly 67 is in the cutting position, to produce – through the transverse cutting element 69 - the initial free end of the new roll, the contrast roller 73 is brought into contact with the new spindle 45, so that the web material N is nipped on one side between the winding roller 51 and the newly inserted spindle 45 and on the other side between this spindle and the contrast roller 73. The electrostatic bar 71 electrostatically charges the web material before it is cut by the cutting element 69 operated by the piston-cylinder actuator 79. Once the element 69 has performed the transverse cut on the web material, the final free end is wound on the finished roll R, while the initial free end will start to wind around the new spindle 45. Initial winding is guaranteed by electrostatic attraction between the web material electrostatically charged by the bar 71 and the metal part of the spindle 45, which is at zero potential.

To prevent the web material from starting to wind, with its initial free end, around the contrast roller 73, this is made of non-electrically conductive material. The electric capacitance of the spindle 45 is thus sufficient to guarantee adhesion of the free end of the web material produced by the cut performed by the element 69. After the first complete turn has been formed around the winding spindle 45, the assembly 67 may be removed from the winding zone through a clockwise oscillating movement and the spindle 45 may be engaged at its ends by rollers 47 carried by the slides 49 on the sides of the machine. Winding continues in these conditions until completion of the subsequent roll.

Just as in the previous example of embodiment, the machine represented in Figs. 3 and 5 is also provided with a longitudinal cutting assembly, indicated schematically with 78, to divide the web material N into a series of longitudinal strips narrower in width to the overall width of the web material. When the web material is cut longitudinally, the various strips are wound on tubular winding cores

positioned beside one another on the single spindle 45. In this case the roll or reel B will actually be formed of a series of rolls of a shorter axial length positioned side by side.

Figs. 6, 7 and 8 show a modified embodiment of a reeling drum or winding machine which, analogously to the machine shown in Figs. 3, 4 and 5, is capable or performing the exchange phase, i.e. unloading the completed roll, inserting the new spindle and starting to wind a new roll on said spindle without interrupting feed of the web material.

In this embodiment, a supporting surface 101 is provided on which a winding spindle 103 rests to form a roll or reel R around it. Also in this case the roll or reel R may actually be constituted by a plurality of rolls with a shorter axial length positioned on the same spindle. Rollers 105 carried by oscillating arms 107 hold the roll being formed R in contact with a winding roller 109, around which the web material to be wound, indicated with N, is fed. A longitudinal cutting assembly 111 is provided to divide the web material into continual longitudinal strips if so required.

While a roll or reel R is being formed, carried in rotation by the winding roller 109, a new winding spindle 103 is engaged by a pickup system 113 of a per se known type (Fig. 7).

An assembly indicated as a whole with 115, rotates around the axis 109A of the winding roller 109, and is used to cut the web material and start winding a new roll around a new winding spindle 103 inserted in the winding zone by the pickup system 113. The assembly 115 is shown in detail in Fig. 8. It comprises a transverse cutting element constituted by a blade 117 mounted oscillating around an axis 119. The oscillating movement is controlled by a piston-cylinder actuator 121, the cylinder of which is mounted oscillating by a bracket 123 on the oscillating assembly 115. Mounted at the sides of the axis of oscillation 119 of the blade 117 are two guiding rollers 125 and 127, between which a curved section bar 129 is positioned. An electrostatic bar 131 is mounted under the guiding roller 125.

The machine shown in Figs. 6 and 8 performs the exchange, i.e. replacement of a complete roll or reel R with a new winding spindle 103, in the

following way. Without interrupting feed of the web material, while the roll R is completed maintaining it in contact with the winding roller 109, the assembly 115 rotates clockwise from the position in Fig. 7 to position itself between the web material N being fed to the roller 109 and the roller itself. The clockwise rotatory movement continues until reaching the angular position in Fig. 6, before the unit 113 moves from the position in Fig. 7 to the position in Fig. 6 with clockwise oscillation. Insertion of the new spindle 103 in the position in Fig. 6, in which winding of a new roll commences, thus occurs subsequently to movement of the assembly 115 beyond the insertion position of the new spindle 103.

When the assembly 115 and the unit 113 have reached the position in Fig. 6, the web material is cut and transferred to the new spindle. In the layout in Fig. 6 a loop of web material N is formed around the assembly 115, being driven on the two guiding rollers 125, 127 and on the curved section bar 129. Before operating the transverse cutting element 117, the electrostatic bar 131 starts to electrostatically charge the web material. By operating the cutting element 117 an initial free end of the web material is produced which adheres to the external surface of the new winding spindle 103 positioned in contact with the winding roller 109, with the web material interposed between said spindle and said roller. Adhesion through electrostatic effect of the initial free end to the spindle instead of the winding roller 109 is guaranteed by the fact that in this case the winding roller 109 is made of non-electrically conductive material. The electrical capacitance of the winding spindle 103 is thus sufficient for the web material to adhere to it, notwithstanding the presence of any winding cores in non-conductive material positioned on the metal spindle 103 or in any case notwithstanding the low electric capacitance of the spindle.

Upon completion of adhesion of the initial free end to the new winding spindle 103, the assembly 115 starts rotation in the clockwise direction again, to return to the position in the layout in Fig. 7, thus completing a rotation of 360°, while the roll formed is removed through oscillation of the arms 107. The new winding spindle with the new roll being formed is inserted in the space thus made available. This spindle is then engaged by the rollers 105 as soon as they have been freed of the completed reel and are returned with a counter-clockwise

rotation of the arms 107. The pickup system 113 moves upwards with counter-clockwise oscillation to engage a new winding spindle which will replace the one inserted previously after the new roll has been wound.

The use of a winding roller 109 made at least partly of non-electrically conductive material makes it possible to cut the web material in a much more advantageous position to the one in machines of this type currently employing electrostatic systems to make the free end adhere to the new spindle. In fact, in prior art machines, to prevent the initial free end from winding around the winding roller instead of around the new spindle, it is necessary to produce – during the final phase of winding the reel and before the web material is cut – a loop which surrounds the new spindle 103 by about 180°. In substance, the trajectory of the web material extends around the roller 109, around a guiding roller in an analogous position to the roller 125 in Fig. 8 and also around one or more guiding rollers positioned further back towards the zone from which the web is fed in relation to the position of the new spindle. The cut must then be made in a position further back in relation to the spindle so that the free end adheres to this under the effect of electrostatic attraction produced both by the spindle and by the winding roller.

This known configuration is particularly unfavorable due to the great number of guiding rollers and the twisted path which the web material must follow before being cut, with consequent excessive stress of the material.

It is understood that the drawing only shows possible embodiments of the invention, which may vary in form and layout without however departing from the scope of the concept underlying the invention. The presence of any reference numerals in the attached claims are provided purely to facilitate reading in the light of the description above and the attached drawings, but do not limit the scope of protection thereof.